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FINAL REPORT SD-TR-79-23

6 SATELLITE INFRARED (SIRE) SENSOR DATA PROCESSING

PERSPECTIVE AND DEFINITION, VOLUME I.

FINAL REPORT FOR PERIOD

APRIL 1978 THROUGH DECEMBER 1978

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Prepared for

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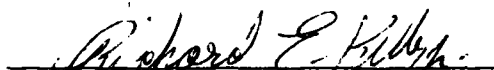999 North Sepulveda Boulevard
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This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

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As a consequence of its extensive background in infrared technology and data processing of experimental measurements, Riverside Research Institute was selected by the Air Force's Space and Missile Systems Organization to provide a data processing perspective to the development of the Satellite Infrared (SIRE) Sensor, and establish requirements for the SIRE data processing and the system and operations for that processing.

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Blk. 20: While this activity has continued uninterrupted since 1976, the emphasis of this report is in the review of RRI's activities from April through September 1978; an interim report of RRI's work from December 1976 through March 1978 has already been issued. The topics covered in this report can be divided into four principal areas: (1) data processing perspective to the SIRE payload, (2) SIRE data processing requirements, (3) definition of the SIRE Coordinator, and (4) survey of applicable commercial and DoD data reduction techniques to SIRE.

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AUTHORIZATION

     This report describes research performed at River-side Research Institute and was prepared by Thomas Ciccarelli and Ronald Cestaro.

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<u>FINAL REPORT</u>
<u>SATELLITE INFRARED EXPERIMENT (SIRE)</u>
<u>DATA PROCESSING PERSPECTIVE AND DEFINITION</u>

I. <u>INTRODUCTION</u>

The Satellite Infrared (SIRE) Sensor sponsored by the Air Force's Space and Missile System Organization (SAMSO) is a program whose objectives are to obtain data to aid in the definition, evaluation, and design of an operational long wavelength infrared space surveillance system, e.g., the Deep Space Surveillance Satellite System (DSSS). The experiment will be conducted from a low-altitude, space-borne platform with a ten-to-twelve-month duration in the 1981 period. Data collected will aid in the definition of relevant target and spatial and temporal background signatures, resolve key space-based technology issues, and demonstrate the military potential of long wavelength infrared surveillance satellite concepts.

RRI has extensive infrared technology background and has participated in data processing tasks on several SAMSO-sponsored space-based infrared background measurement programs such as the Celestial Mapping Program and the Earth Limb Measurements Program. Consequently, RRI was selected by SAMSO to provide a data processing perspective to the development of the SIRE sensor and establish requirements for the SIRE data processing and the system and operations for that processing. This activity, which began in 1976, has continued uninterupted to the present.

An interim report[1] which provides a review of RRI's work through March 1978 has already been issued. Hence, this report

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[1] Numbered References appear in Section V.

will emphasize RRI's efforts from the time of that interim re-
port to the present. Where RRI work performed in this period
has already been described in formal CDRL responses provided to
SAMSO, this report serves to reference those responses and to
provide a summary which highlights the more significant results
of that work. Additional RRI work performed in the areas of
Requirements Monitoring and Special Tasks requested by SAMSO
are reported upon in the body of this report and in its associ-
ated appendices.

II. PROGRAM DEVELOPMENTS

A. WORK SUMMARY: PRIOR TO MARCH 1978

The Institute's involvement with SAMSO's SIRE program, under the current contract, began on 1 December 1976. Actually, RRI's direct involvement in this program began eight months earlier when RRI support on SIRE was contracted by SAMSO through AMICOM (from 1 April through 30 November 1976) on an existing RRI DARPA-sponsored contract.

In 1976, the Institute's principal function was to review and evaluate the SIRE experimental objectives, mission planning, and focal plane assembly design in order to ensure that the experimental objectives could be achieved.

Starting in December 1976 and continuing to the present, RRI's objectives in the SIRE program have been directed toward providing a data processing perspective to the development of the SIRE payload and establishing requirements for the SIRE data processing and the system and operations for that processing. Tables I and II outline RRI's principal areas of activities and illustrate some of the various task outputs reported upon during that period.

In March 1978, RRI, obtained a Supplemental Agreement (SA) to its SIRE contract in order to permit RRI activities to extend beyond the original contract period. The objectives of RRI under the SA were directed toward continuing the aims of the original contract and to further assist SAMSO in closely related tasks while the Data Processing System (DPS) contractor (NASA/Ames and IAC) began it's initial efforts and became familiar with the SIRE program and data processing requirements.

TABLE I.

OUTLINE OF RRI TASKS PERFORMED THROUGH MARCH 1978

● **SIRE Data Processing Definition Study**

Defined, directed, and participated in the development of independent baselines for the SIRE Data Processing System. With the support of two subcontractors, Hughes Aircraft Company and IBM, independent formulations of the data processing system were defined and sized. This task laid the groundwork for the generation of the SAMSO required procurement documents for SIRE data processing and served to identify to SAMSO the technical issues involved.

● **SIRE Data Processing Procurement Materials**

Generated the Technical Requirements Document, the Statement of Work, and supporting evaluation materials for the Source Selection Board. Provided costing, implementation, and change/impact information.

● **Data Processing Support Studies (Data Processing Contractor "Surrogate")**

Derived independent payload-response models and effects. Reviewed and interpreted mission requirements. Reviewed the HYSAT studies and generated SIRE implications. Assisted in technical evaluation of specific proposals, presentations, and reports. And, upon request, provided special presentation materials for SAMSO.

TABLE II.

TYPICAL DATA PROCESSING SUPPORT STUDY
ACCOMPLISHMENTS THROUGH MARCH 1978

● Payload-Data Processing Issues

Developed modelling of trans-impedance amplifiers and AC
coupling effects, and the log A/D converters. These models
were used in determining such effects as filter cutoff
response vs signal-to-noise, background-induced bias effect
and quantizer losses in the A/D converter, and NEFD/NER de-
pendencies in HAC's sensitivity equations. Reviewed pay-
load System Design Review and Preliminary Design Review to
assess implications in data processing design and its
implication upon the payload design.

● Mission/Experiment Requirements Reviews

Characterization of SIRE data requirements as to their
utility for DSSS support. Examination of the utility for
SIRE to provide additional IR measurements in the MWIR as
well as the LWIR range. In conjunction with Air Force
Geophysics Laboratories, development of Earth Limb Measure-
ment requirements. Development of Proof-of-Concept exper-
iment requirements. Specification of a SIRE simulator.

● HYSAT Studies Review

Assessment of SIRE implications and a comparison of the
various requirements and designs proposed.

TABLE II.   CONTINUED

●   <u>General Data Processing Analyses</u>

Produced primary description of required SIRE data analysis
output formats. Conducted survey of available GFE data
processing hardware for possible use by SIRE contractors.
Performed survey of SIRE-related data processing hardware,
data base management systems, and graphics capabilities.
Assessed applicability of ADCOM's data for use in SIRE
data processing.

B.   **WORK SUMMARY: SINCE MARCH 1978**

The tasks performed by RRI under the SA can be divided into four principal activities:

(1)   Providing a data processing perspective to the development of the SIRE payload,

(2)   Requirements Monitoring,

(3)   Establishing the potential roles and structure of the steering group designated as Experiment Coordinator, and

(4)   Performing a survey, at the request of SAMSO, of Commercial and DoD data reduction techniques.

In the first of these activities listed, RRI continued the role initiated under the original contract by providing the data processing perspective to the development of the SIRE payload beyond its Critical Design Review (CDR). The Hughes Aircraft Company (HAC) CDR and related documentation were reviewed, evaluated, and formally reported upon[4] by RRI.

In the area of requirements monitoring, RRI has provided a data processing perspective to the further definition of data collection as it arose in several SAMSO-planned working groups on measurement, data processing, and experiment issues. As directed by SAMSO, RRI assisted in the definition and clarification of interfacing and processing issues by attending and providing comments on various DPS contractor/payload contractor coordination meetings. Based upon previous RRI activities in the SIRE data processing definition, RRI reviewed and assessed the implications of the HAC/NASA Data Processor Systems Requirements Review (SRR), the HAC SIRE Ground Segment Specification and the HAC SIRE Ground Segment Concept and System Description document. Comments and questions raised are covered in this report and in Appendices B and C.

RRI has also assisted SAMSO in the planning for the SIRE
program by defining and assessing the requirements and inter-
faces for the steering group designated by SAMSO as the Ex-
periment Coordinator. The results of this task were orally
presented to SAMSO and are formally documented in Ref. 3 and
Section IV, D.

Finally, at the request of SAMSO, RRI performed a survey
of Commercial and DoD data reduction techniques with the intent
of providing low cost data reduction options to SAMSO's planning
on SIRE. The results of this survey were orally presented to
SAMSO and are documented in Appendix A of this report.

III. RECOMMENDATIONS

As a result of RRI's activities for SAMSO, the Institute recognizes that a number of areas in the Ground Segment's development will require further analysis and definition. The following is a list of recent recommendations that RRI has made known to SAMSO, and that RRI suggests be considered by SAMSO for implementation during FY 79.

A. SENSOR DEVELOPMENT: IMPACT OF POSSIBLE SENSOR MODIFICATIONS ON DATA PROCESSING

In the area of sensor development, sensor modifications are required if the mission requirements on earth limb measurements are to be fully met by SIRE. It is known that HAC has proposed modifications to enhance sensor operation for this experiment. If these modifications are to be made to the sensor, there is a need to evaluate the impact of such modifications on data processing. Depending upon the specific modifications made, there may be a need to reevaluate the performance of the sensor for each of the experiments.

B. GROUND SEGMENT DEVELOPMENT: INTERFACE BETWEEN ASSOCIATE GROUND SEGMENT CONTRACTORS

In Ground Segment development, a number of areas of concern need to be addressed. These include:

(1)   There is a need to finally define responsibilities between the associate Ground Segment Contractors, i.e., NASA and HAC.

(2)   There is a need to establish a working interface between NASA and HAC during the development phase of the program.

(3)   There is a need to obtain a reliable development schedule for NASA as soon as is possible.

(4)   There is a need to give serious thought to what data products are to be produced by the program after the operations phase.

C.   PHASED IMPLEMENTATION OF SIRE GROUND SEGMENT

Due to cost and schedule considerations in the development of the SIRE Ground Segment, a phased implementation of the Data Processing Subsystem is being considered. Under this implementation concept, the development of the Data Analysis Subsystem (DAS) would be delayed possibly to the period when on-orbit operations are in progress or later. If such a phased implementation occurs, there is a need to define the intermediate SIRE outputs required by the Quality Evaluation and Experiment Planning subsystems in order to guarantee that data needed to fulfill the mission requirements are obtained.

D.   DATA PROCESSING: BATCH VS INTERACTIVE PROCESSING

IR data processing centers surveyed by RRI have developed and successfully used, or are in the process of developing, data processing systems ranging from highly automated, batch mode systems to highly interactive and image processing systems. All of the centers surveyed had to contend with unexpected problems which required software updates after real data was obtained. Interactive systems have the advantage of placing a human operator in view of the data and provide flexibility to cope with unexpected effects. However, extensive manual interaction may limit throughput rate and, coupled with the large amount of data to be gathered by SIRE, may lead to the requirement for many terminals or to a data backlog. Specific SIRE requirements in this area need to be quantified and appropriate

trade-off studies performed to determine the type (i.e., batch vs interactive) and cost of system required.

E. DATA PROCESSING: COST OF PURCHASED INTERACTIVE SYSTEMS VS INTERNAL DEVELOPMENT OF INTERACTIVE SOFTWARE

Manually interactive systems could potentially be used for the evaluation, assessment and, at least, a partial analysis of SIRE data, and to provide experiment status feedback to Experiment Planning, in lieu of a full, automated data analysis capability.

Commercial interactive processing systems with color graphic terminals are available with costs ranging from approximately $35 thousand to over $1/2 million. The less costly systems have relatively limited capability and would require extensive interface and other SIRE specific software to be developed. The higher priced systems are provided with extensive software but it is supplied with limited rights. Trade-off studies should be performed to determine the cost effectiveness of utilizing the less costly systems, and developing required software vs the purchase of more costly and highly interactive systems.

F. DEFINITION OF EXPERIMENT COORDINATOR

Most recently, RRI was requested by SAMSO to perform a short study to define the requirements for and the responsibilities of a SIRE Experiment Coordinator (EC), the last remaining major undefined SIRE participant. RRI recommends that two principal activities concerning the EC should be carried on in FY 79 to build upon the results of this study and cause the EC to further approach its realization within SIRE. First, the Institute recommends that a more explicit definition of the EC structure and its responsibilities be performed. As a result

of this activity, SAMSO would achieve several important mile-
stones in the EC's development, namely: a firm decision on the
scope and the near and far term objectives of the EC, a decision
on the choice of participants in the EC, a finalization of the
EC's staffing requirements, and initialization of the EC itself
and its responsibilities.

Second, the Institute also recommends that the EC concept
be formally integrated into the SIRE system configuration as a
recognizable entity. Interfaces should be formalized and proto-
cals established. This is essential if a functioning and support-
ive EC is to be fully operational in time for the SIRE launch.

IV. ACCOMPLISHMENTS

A. DATA PROCESSING PERSPECTIVE OF SIRE PAYLOAD DEVELOPMENT

As part of its efforts on the SIRE program, RRI has pro-
vided a data processing perspective to the development of the
SIRE payload. In this area, RRI has reviewed, evaluated and
performed analyses on specific technical issues related to the
HAC payload design. RRI has previously reported to SAMSO upon
its work[4],[5] in the review of the Payload System Design Review
(SDR) held in December 1976 and the Payload Preliminary Design
Review (PDR) held in July 1977.

The results of RRI's review and evaluation of the HAC SIRE
sensor subsystem Critical Design Review (CDR) held in July 1978
are presented in Ref. 2 and are summarized here. This review
addressed the CDR design specifications and estimate performance
which would determine data collection requirements and the valid-
ity and accuracy of the resulting processed data. In the eval-
uation of the CDR, the capabilities of the sensor subsystem, as
presented at CDR, were examined for each of the data collection
experiments identified as part of the SIRE mission. A comparison
of expected "average" performance data from CDR was made with
those needed to satisfy the SIRE mission requirements. The re-
view included a reevaluation of the pertinent analyses and cal-
culations presented at CDR and included investigations into some
additional areas of concern not included at CDR. Some of the
results of the Institute's CDR review are:

(1) A comparison of the SIRE mission requirements pre-
sented in the SIRE Mission Requirements Document[6] to those
summarized at CDR indicates that there are some inconsistencies

in the requirements; e.g., the Noise Equivalent Radiance (NER)
requirement for the distributed background measurements pre-
sented at the SIRE CDR is a factor of 15 higher then that given
in the Mission Requirements Document. HAC has stated at CDR
that the Mission Requirements Document will be updated as part
of its SIRE Total System Integrator (STSI) contract. Such
clarification of the SIRE mission requirements would be useful.

(2)   Average and Worst case Noise Equivalent Flux Density
(NEFD) values used to estimate target measurement performance
were given at CDR for a zero background condition (this corre-
sponds to sensor or internal noise limited operation). A com-
parison of those values with the mission requirements indicated
that the Category I requirements are met. However, the Cate-
gory II requirements are not quite met, although the values
are borderline, if average NEFD values are assumed. Worst case
NEFD (approximately a factor of 2 higher then the average values)
do not appear to meet the system requirements as they are cur-
rently known by RRI.

(3)   Background limited NEFDs were examined by RRI assum-
ing various zodiacal radiance background levels as predicted
by current, tentative models. In all such cases the required
sensitivity is not achieved, although it should be noted that
the requirement was established assuming a benign background
condition. Hence, this exemplifies the need for careful ex-
periment planning to assure that the desired measurement
sensitivities are achieved under all measurement conditions.

(4)   In the case of diffuse background measurements, ex-
pected Minimum Detectable Radiance (MDR) levels were computed
for the zodiacal and earth limb measurement experiments. The
zodiacal radiance measurement requirements are met in all cases.
In the case of the earth limb measurements, however, the re-

quirements are not met with the sensor as configured at CDR (HAC proposed sensor modifications for earth limb measurement enhancement were not presented at CDR and were not included in RRI's CDR review documentation). A comparison with tentative model earth limb data indicates that, although the requirements are not met, measurement operation may be possible in the emission bands. With the exception of band 12, however, window band measurements do not appear to be possible at the lower tangent heights required.

(5)   For the stellar experiment, the required NEFD corresponds to star density sample levels a threshold factor of approximately 3 above the NEFD if single-look detection is assumed. The resulting required sensitivity is not achieved for any of the assumed zodiacal background conditions. This implies that some form of multiple look detection algorithm will most likely have to be implemented in the ground processing.

B.   SIRE GROUND SEGMENT REQUIREMENTS MONITORING & DEFINITION

RRI has participated in a series of meetings pertaining to the SIRE Ground Segment Requirements Review, held by HAC and NASA. RRI staff members attended the System Requirements Review on 16 October 1978 and subsequently, participated in the detail review of the HAC-generated requirements documents, namely: the "Ground Segment Specification,[7]" and the "Ground Segment Operations Concept and System Description Document.[8]" Detailed RRI comments and questions raised are given in Appendices B and C. Four principal observations are summarized below:

(1)   Division of Responsibilites

It appears that, at this time, the issue of Ground Segment functional responsibility is unresolved. Both HAC and NASA have avoided direct confrontation with the other over this

point, but this option may soon disappear. A good example is
in the formulation of the Experiment Planning Subsystems (EPS)
procedures. During meetings attended by RRI, NASA assumed the
attitude that they were participating in the planning/decision
processes; not just performing data generation tests for HAC
planners. Another example is with the Quality Evaluation Sub-
system (QES) and its "evaluation" procedures. NASA stated that
since they are designing and implementing the subsystems they
will be the "best" choice for performing the various functions;
otherwise, NASA will be, in essence, deciding how HAC evaluators
will do their job. Since NASA is to write the Part Is and IIs
they will have strong justification for making this claim. This
issue needs to be resolved, possibly by SAMSO, as early as pos-
sible.

(2)   Development Interface Between HAC and NASA

As the program approaches the SDR milestone, it is becom-
ing increasingly apparent that there exists a need for a formalized
interface between NASA and HAC during the Development Phase. At this
time, the NASA/HAC ICD* is concerned only with their relationship
during operations. In order for NASA to properly prepare the
draft of the Part I specifications, it needs detailed technical
knowledge of the sensor performance and experimental measurements
concepts. HAC is a logical and obvious source for this data.
NASA might be able to secure this data and expertise elsewhere,
but only at significant cost and effort. There is an urgent
need for NASA to establish a firm development schedule and out-
line of the required development data interfaces with HAC. It
must be realized that HAC probably has not allocated the man-
power to staff this interface. Both documentation and frequent
technical interchange will be required.

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*   Interface Control Document

(3)   Development of a Realizable Development Schedule

At this point in time, it seems highly probable that
NASA will not meet the full SDR milestone, at least for the
application software and, possibly, the system software as well.
Assuming that this is the actual situation, NASA should produce
a realizable development schedule soon with sufficient detail
to indicate the expected software development milestones.

(4)   Data Products Definition

To date there has been a good deal of conjecture on
what SIRE should output. The nature, quality and quantity of
these outputs will strongly size the Data Analysis Subsystem
(DAS) function in terms of cost and effort. The outputs have
never been clearly definitized; it was expected that the DSSS
program would produce the necessary output product definitions
to support its development. RRI has produced a report[9] des-
cribing the spectrum of output possibilities. Both HAC and
NASA have also visualized the various forms these outputs can
take. Intermediate outputs also need to be defined, partic-
ularly if it is required to delay the development of the DAS.

Orginally, SAMSO considered the Simulation Subsystem
to be an output product, to be used by the DSSS program. The
Institute recommends that this option be sized as to cost.
This option would require SIRE to "validate" the Simulation
Subsystem. A validated simulation would give significant
assistance to SAMSO in helping to evaluate and choose candidate
DSSS designs, and it would be of immense value to the DSSS
contractor during the development stage.

In addition, the Institute recommends that some
thought be given to the nature of the library to be left after
SIRE is completed. The "true analysis" of SIRE data will be
performed, it is felt, after the DAS function is completed, un-

less DAS incorporates DSSS-like design analyses. Consequently, a functioning Data Base Management System (DBMS) would be of immense aid in any post-DAS period, both to SAMSO and any DSSS-associated contractors. Having the huge amount of SIRE data stored in presently-envisioned formats without some mechanized means of retrieving, cross-correlating, or parameterizing the data in a flexible manner could seriously jeopardize the ultimate use of the data or the realization of its full value. The cost of preserving a DBMS option should be examined.

C. SURVEY OF COMMERCIAL AND DoD DATA REDUCTION TECHNIQUES

At SAMSO's request, a limited survey of commercial suppliers of image processing equipment and commercial and DoD IR data reduction centers was performed. A detailed report on this survey is presented in Appendix A. This section summarizes the purposes and results of this survey.

The objective of the survey was to assess the commercial availability of IR data processing hardware and software with emphasis on manually interactive (image processing and color graphic display) systems and to review the experience of other IR data reduction programs as to their design philosophies, development and operational costs, degree of manual interaction utilized in their data reduction processes, problems they encountered, etc. Interest in manually interactive systems resulted from various suggested SIRE data processing system configurations which could permit the evaluation, assessment, and at least a partial analysis of SIRE data, and the required experiment status feedback to experiment planning, in lieu of a full, automated data analysis capability. It was an objective to assess the utility of interactive systems used in such a mode, and to evaluate the extent to which such systems would cost-impact the SIRE data processing system.

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The potential sources of commercial hardware and/or software surveyed were the Electromagnetic System Laboratory (ESL), COMTAL, RAMTEK, and the University of Southern California (USC). The Jet Propulsion Labs (JPL), Teledyne Brown Engineering, Air Force Geophysics Laboratory (AFGL) and ESL were surveyed with regard to their experience in IR data processing.

Commercial interactive processing systems with color graphic terminals are available with varying capabilities and cost ranging from peripheral-only systems with very limited capability costing approximately $35,000 to full turnkey systems with array processors and extensive interactive software costing $500,000 to $600,000 and more. The less costly systems with relatively limited capability would require the development of interface and other SIRE specific software. This would increase the overall cost of using these systems. The higher priced systems have extensive software but it is supplied with limited rights. This may make user modification of supplied software difficult.

The chief cost drivers of interactive systems are the required memory size, the required throughput rate, and required specialized algorithms. Memory size is driven by the desired display resolution, and the number of images and amount of data to be stored within the interactive system. Required throughput rate is driven by the amount of data to be processed, the processing to be performed and the turnaround time required. Software required is driven by the desired outputs and displays. Hence, it is suggested that the amount of SIRE data to be processed, the extent of interaction required, the display resolution required and the throughput rate required be quantified, and the specific types of displays and interactive capabilities (algorithms) desired be quantified so that refined system sizing cost estimates can be generated. Trade-off studies should be

performed and should include a determination of the cost effectiveness of using the less costly peripheral systems, and developing the required software vs the purchse of the more expensive and highly interactive systems.

The IR data processing centers surveyed have developed and successfully used, or are in the process of developing, data processing systems ranging from highly automated, batch mode systems to highly interactive and image processing systems for the reduction of IR data. The experience of these centers indicates that real data are required before refined, automated computer algorithms for the processing of IR data can be developed. All of the surveyed centers who have processed IR data had to contend with unexpected problems which required software updating. Manually interactive systems have the advantage of placing a human operator in view of the data so that on-the-spot decisions can be made and optional algorithm techniques can be quickly applied to cope with unexpected results. In addition, due to the interactive nature of these systems, they are valuable tools in the development and testing of new algorithms. However, extensive manual interaction tends to limit the throughput rate and can potentially lead to low turnaround times or the need for many interactive terminals. Sufficiently low turnaround time in the SIRE case can result in data backlogs and reduced feedback capability to experiment planning. On the other hand, the use of many interactive terminals, if this be necessary, can drive up the system cost. Again, the specific SIRE requirements need to be quantified and appropriate trade-off studies performed to determine the type (e.g., batch vs interactive system) and cost of the system required.

A number of the IR data reduction centers have experience with processing data of the type and quantity to be found in SIRE. Along with RRI, JPL and AFGL are potential sources of valuable

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information for point source processing and boresight reconstruction algorithms. AFGL also has experience in the processing of zodiacal and earth limb data. Teledyne Brown Engineering has developed tracking algorithms for reentry systems albeit under less stressing target signal and background noise conditions than is expected for SIRE. They have also had to cope with many unexpected system problems, which may or may not be applicable experience for SIRE. ESL has extensive experience in the use of interactive, color graphic systems and in their usage for the processing of IR track data on classified programs.

D. EXPERIMENT COORDINATOR DEFINITION STUDY

At this point in its development, the SIRE program has identified all but one of its major participants, the Experiment Coordinator. What it is, why it is needed, and who it should be is the subject of a short examination undertaken by RRI at the request of SAMSO. This section briefly presents the "highlights" of this examination.

1. Study Approach

Figure 1 identifies the principal SIRE participants, as well as the lines of responsibilities. Briefly, the SIRE Total System Integrator (STSI) contractor (HAC) is responsible for "the development of system requirements, top-level plans, function specifications, and operations concepts." In addition, the STSI will integrate the various segments of the system, monitor segment interfaces and perform experiment planning and data quality evaluation functions. The data processing (DP) contractor (NASA) is responsible for developing and operating the hardware and software for most of the Ground Segment functions/facilities,* including the production and distribution of

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* HAC is developing and operating the SIRE Simulation Subsystem.
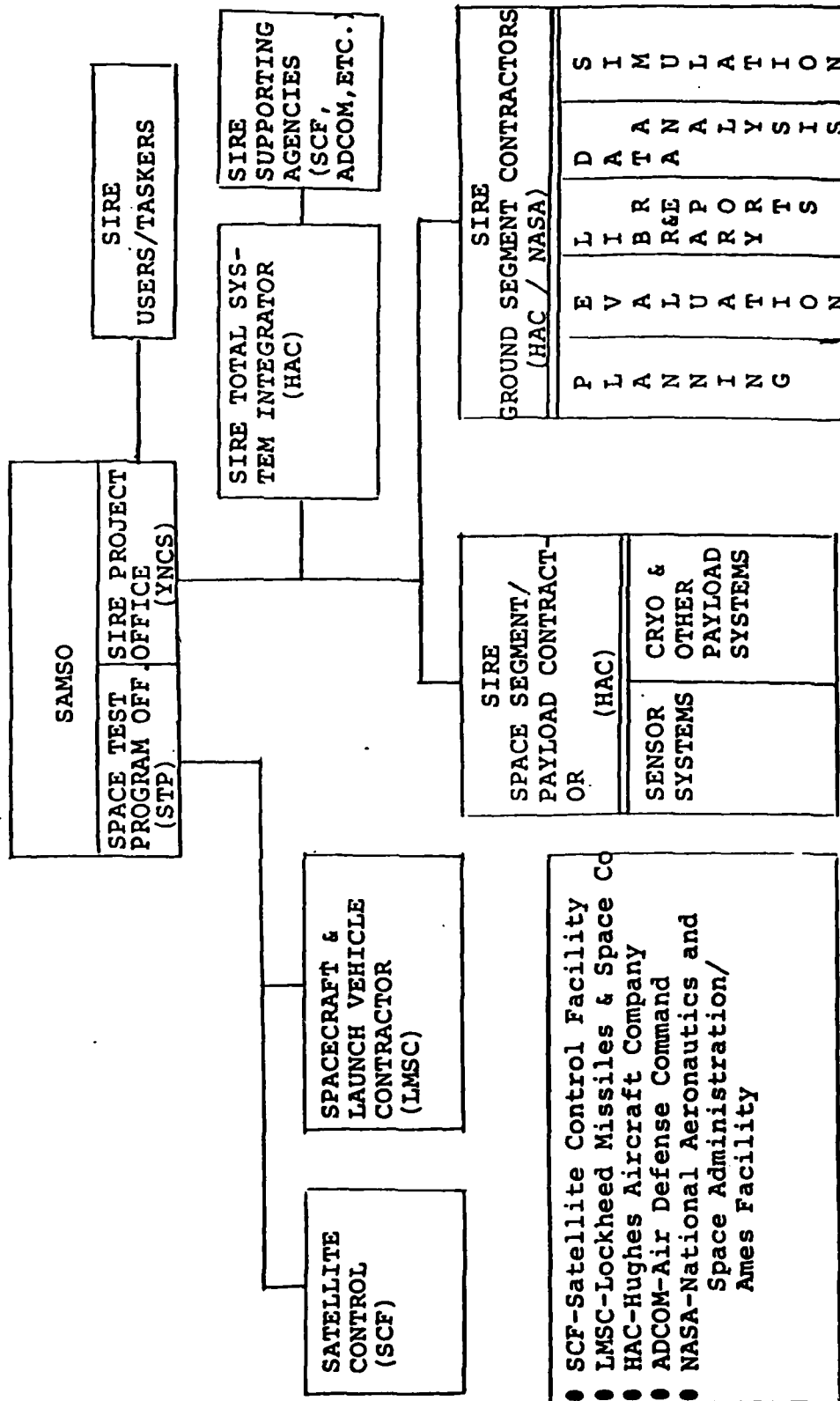
FIGURE 1 - SIRE PARTICIPANTS

Boxes in diagram:

SIRE USERS/TASKERS

SIRE SUPPORTING AGENCIES (SCF, ADCOM, ETC.)

SIRE TOTAL SYSTEM INTEGRATOR (HAC)

SIRE GROUND SEGMENT CONTRACTORS (HAC / NASA)

PLANNING AND DEVELOPMENT; LIBRARY; ABR; R&E; APPLICATION; ANALYSIS; SHIMURA THIOSIS

SAMSO

SPACE TEST PROGRAM OFFICE (STP) | SIRE PROJECT OFFICE (YNCS)

SIRE SPACE SEGMENT/PAYLOAD CONTRACTOR (HAC)

SENSOR SYSTEMS | CRYO & OTHER PAYLOAD SYSTEMS

SPACECRAFT & LAUNCH VEHICLE CONTRACTOR (LMSC)

SATELLITE CONTROL (SCF)

- SCF—Satellite Control Facility
- LMSC—Lockheed Missiles & Space Co
- HAC—Hughes Aircraft Company
- ADCOM—Air Defense Command
- NASA—National Aeronautics and Space Administration/ Ames Facility

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data reports. The payload contractor (HAC) is developing the
sensor and supporting sensor subsystems (cryogenics, on-board
electronics, gimbals, shields, etc.). The SIRE users will be
a group of SAMSO program offices, DoD agencies, and DoD con-
tractors directly receiving SIRE data outputs and reports.
Taskers are a subset of this user group and are allowed to
make requests (directly or indirectly) upon the STSI and DP
contractors for specific measurements and data reports.

There is no one group, aside from SAMSO/YNCS, nor is
there an allocated function for coordinating the various
functions within SIRE. All approval for requests from outside
groups, all control of intergroup interactions, all monitoring,
review and approval of program developments, all generation of
long range plans and modifications, etc. are funneled from or
through the SIRE Project Office. The performance of these
functions are presently outside of the currently defined roles
for STSI and DP contractors, and these burdens fall mainly upon
YNCS.

RRI was requested by SAMSO to examine the situation
described above and define a technical and management entity
that could assist YNCS in a number of desired functions. The
Institute was to define what this entity, the Experiment Coor-
dinator (EC), is, or could be.

RRI's approach in defining the nature and scope of a
SIRE EC was strongly influenced by its long experience in de-
signing program structures for DARPA and other DoD agencies.
In particular, the Institute drew heavily from the coordination
entity it had set up for DARPA's High Altitude Large Optics
(HALO) program. RRI sees the EC as having multi-varied func-
tions; able to respond and fulfill particular program needs
which, for one reason or another, cannot be conveniently (or

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for practical considerations) performed by an existing SIRE
participant. Some of the envisioned uses of an EC group are
to provide a) experiment administration or coordination, b)
scientific resources for review, c) complementary technical
support in the Ground Segment, d) the structure for extended
program participation, and e) wide program visibility in the
DoD community.

2. SIRE's Need for an Experiment Coordinator

a) General Needs

In the years remaining on the SIRE program the
SAMSO/SIRE management will be faced with large numbers of
critical technical questions, and timeliness of response will
be essential if program risk and costs are to be controlled,
if not reduced. To meet this response, SIRE management re-
quires insight into a large variety of intricate technical
issues, calling for indepth experience in order to make the
necessary decisive and timely decisions. SIRE management must
be technically responsive.

The evolving SIRE system has produced specific
technical responsibilities, as well, for SAMSO. The STSI, in
its SIRE Operations Concept[8] and the Ground Segment Specifica-
tion[7] has specifically configured a distinct role for SAMSO/YNCS.
SIRE management will require dedicated manpower resources.

The interface task between the STSI and DP con-
tractors will be a critical one during the development phase.
Because of the system's structure, the primary interface role
between the STSI, the DP and the various Taskers/Users has
fallen on SAMSO.

b) Specific Needs

To enable SAMSO/YNCS to perform the assigned
tasks (roles) as described above, there will be a need for

specific support personnel. The first category of required SAMSO-SIRE support is the technical advisor (TA). These individuals are full time, fully accessible technical resources, assisting SAMSO in the monitoring of various SIRE technical areas (e.g., the Aerospace role), providing supplementary technical assistance to the program and insight/visibility into the "inner workings" of the STSI and DP efforts. These individuals can serve SAMSO as their "eyes and ears," keeping YNCS fully cognizant of current program progress and supplying them with sufficient data to make timely decisions.

The second category of support is that of technical reviewer (TR). These individuals are part time technical resources who principally participate at major technical reviews and provide technical advice and evaluation to the SIRE management. These would be the "experts," "consultants," etc. who could not be expected to devote a majority of their efforts to SIRE or provide continuous service. The principal issue in utilizing such support is how to fully exploit the total potential of all the assembled experts so as to be able to constructively focus their separate and, at times, uncorrelated efforts and address those issues that are of concern to SAMSO.

The third category, "proxy" representative (PR), arises from the potential need to complement Air Force personnel in some functions (primarily interfacing), if SAMSO manning levels prove inadequate. (This possibility was voiced by Col. Randolph for YNCS on 31 March 1978.) The PR would provide coordination of technical advisors and reviewers and serve as an interface for SAMSO with SIRE participants and users. The PR would represent SAMSO in technical discussions and decisions where and when necessary. The exact nature and scope of this role has to be defined by SAMSO.

c) <u>Other Needs</u>

As a result of the general and specific needs described above, a set of subsequent needs are derived. First, due to the variety and phasing of the special assistance required by SAMSO, there will be a need to coordinate the various TAs and TRs. Second, with SAMSO being the principal interfacing entity among the SIRE participants, SAMSO needs to incorporate the Tasker/User Requirements into the SIRE program in a formal manner; it must establish procedures for disseminating results outside of the program. Third, it is to SAMSO's benefit to utilize in SIRE the experiences and data of other IR target and background measurement programs. Consequently, there is a need to establish channels by which this supporting data can be gathered and systematically infused into the SIRE program. Fourth, it has been the Institute's long experience with programs like SIRE, which will have impact on IR surveillance system development efforts both inside and outside of SAMSO, that it will be very beneficial to SAMSO to attract wide participation and interest in SIRE throughout the DoD community in order to publicize the importance of its output. SAMSO's principal concern here will be on focusing this attention and possible participation in a constructive manner. Fifth, it is recognized that the program participants have resource limitations. SAMSO will have a need to have access to alternative technology resources, complementing, or even supplementing, those of the SIRE contractors in the performance of program tasks. The algorithm development area is a good example of where additional assistance is required; data analysis and system (mission) implication is another.

3.   <u>Description of Experiment Coordinator Role and</u>
     <u>Responsibilities</u>

a.   <u>Tasks/Scope</u>

In response to SAMSO needs, the Institute has configured the role of the EC as encompassing four major task areas. The first task is that of coordinating the inputs of the advisors and reviewers. This coordination would be required for managing 1) the technical reviews during development, 2) the long term planning assistance during operations, and 3) the data evaluation during operations. The second task is that the EC be a "visible" extension of SAMSO/SIRE management with the Tasker/User community. In this task the EC would be responsible for 1) coordinating all task requests, establishing their priority and evaluating their experiment impact; 2) organizing and coordinating report and data distribution; and 3) insuring visibility of results to DoD community by assisting SAMSO in meeting representation and presentation preparation. The third task has the EC responsible for infusing into the program other available IR measurement data results, as from the IRAS, DOT, and IRB programs. Task four has the EC providing, or making available, technical resources to complement, or supplement, existing program resources. The EC, in this task, could be responsible for managing personnel totally dedicated for this purpose, or coordinating the contributions of TAs or TRs in more than just reviewing functions.

b.   <u>Possible Experiment Coordinator Configuration</u>

Figure 2 shows a likely configuration for the EC group itself. This particular model was successfully implemented by RRI for DARPA in 1976. Basically, SIRE support is to be categorized according to experiments or work areas. For each area a Working Group is then created, each with its own Working Group

FIG. 2   TYPICAL CONFIGURATION FOR EXPERIMENT COORDINATOR
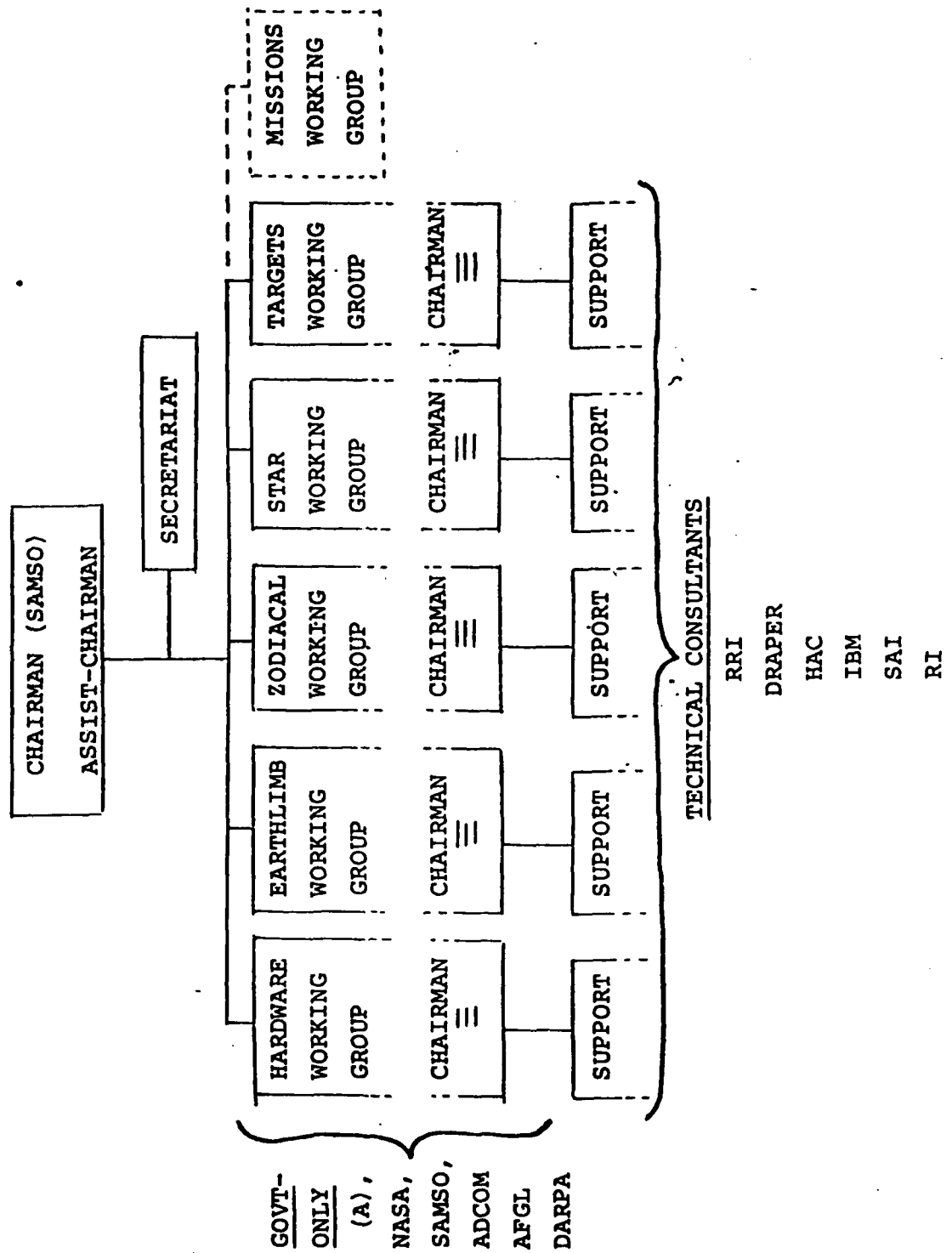
Chairman and Working Group members. All Working Group Chairmen
are appointed by and report to the Chairman, or "titular" EC.
This function is expected to be performed by SAMSO personnel
and is the point of authority within the EC. The Chairman may
be assisted by an Assistant Chairman and is aided by the full
time Secretariat who, in effect, does the actual coordinating
within the "EC," and may be considered the "actual" EC.

As shown in Figure 2, each Working Group may be
comprised of government-only personnel (e.g., SAMSO, NASA, ADCOM,
AFGL, DARPA, etc.) who probably can only participate part time.
Each Working Group is, in turn, supported by Support Groups, com-
prised of non-government personnel (e.g., consultants, pertinent
DoD contractors, etc.) who may be part time or full time. The
split between government-only and non-government working groups
is in recognition of the fact that the government-only groups
provide the vehicle for external SAMSO/YNCS representation in
executive fashion, allowing for segregated meetings when govern-
ment sensitive issues are to be discussed. The Support Group
structure allows for wide industry representation, if desired,
yet isolates them from decision-making processes or knowledge
of government-sensitive issues.

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VI. GLOSSARY

AC   - Alternating Current
A/D   - Analog to Digital
ADCOM   - U.S. Air Force Air Defense Command
AFGL   - Air Force Geophysics Laboratory
AMICOM   - U. S. Army Missile Command
CDR   - Critical Design Review
CDRL   - Contractors Document Requirements List
DARPA   - Defense Advance Research Projects Agency
DAS   - Data Analysis Subsystem
DBMS   - Data Base Management System
DoD   - Department of Defense
DOT   - Designating Optical Tracker program
DP   - Data Processing
DPS   - Data Processing System
DSSS   - Deep Space Surveillance Satellite
EC   - Experiment Coordinator
EPS   - Experiment Planning Subsystem
ESL   - Electromagnetic System Laboratory
HAC   - Hughes Aircraft Company
HALO   - High Altitude Large Optics program
HySAT   - Hybrid Satellite program
IAC   - Institute Advance Computations
IBM   - International Business Machines Corporation
ICD   - Interface Control Document
IR   - Infrared
IRAS   - Infrared Astronomy Satellite

IRB   - Infrared Backgrounds program
JPL   - Jet Propulsion Laboratories
LMSC   - Lockheed Missiles and Space Corporation
MDR   - Minimum Detectable Radiance
MWIR   - Medium Wave Infrared
NASA   - National Aeronautics and Space Administration - Ames
NEFD   _ Noise Equivalent Flux Density
NER   - Noise Equivalent Radiance
PDR   - Preliminary Design Review
PR   - Proxy Representative
QES   - Quality Evaluation Subsystem
SA   - Supplemental Agreement
SAMSO   - Space and Missile Systems Organization
SCF   - Satellite Control Facility
SDR   - System Design Review
SIRE   - Satellite Infrared
SRR   - System Requirements Review
STP   - Space Test Program
STSI   - SIRE Total System Integrator
TA   - Technical Advisor
TR   - Technical Reviewer
USC   - University of Southern California